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Tibor Bercsey & Klaudia Nagy

Applying inventive problem solving methods at the early stage of industrial product design

1 Introduction

The paper introduces a methodological overview followed by thoughts of the recent problems of using these theories at the industrial ground offering some solutions for improvement. Shows a case study where several semesters of the Integrated Product Design courses were observed at the Department of Machine and Product Design at the Budapest University of Technology and Economics (BME). The aim of the presented study has been to evaluate a selected product design project from the aspect of the effectiveness of the previous methodological training. Based on these findings we provide some suggestions for the design education to support the early stage of the design process.

2 Overview of Product Development Methods

It is almost impossible to have a full overview of all the existing product development methods. The following Figure 1 shows a wide range of the available techniques – categorized into three different levels. The first ‚basic' level includes the well-known methods which are easy to learn and use. Mainly the engineers working on the field of innovation are aware of using these possibilities. From the conven-

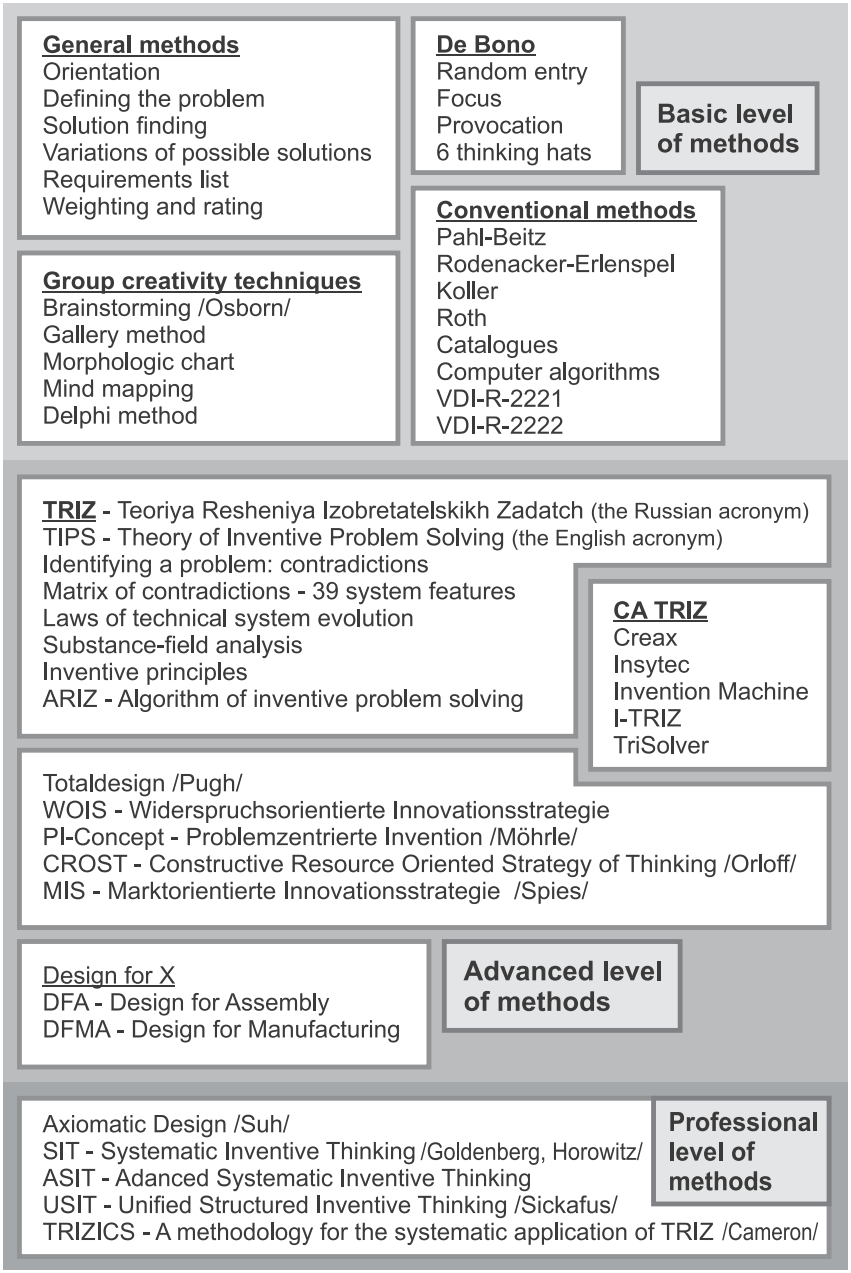

Figure 1: Product design and develompent methodologies.

tional and general steps, through the creativity techniques and a few from the work of Edward de Bono were shown. These methods are mainly part of the industrial design education (Badke-Schaub 2007). At an industrial area the introduction is not necessary but the practice has a major role.

The next ‚advanced' level contains mainly the inventive problem solving methodologies. Many are based on TRIZ – the theory of inventive problem solving. Some innovation strategies are also parts of this category. We had to mention here Design for X, as an opportunity for product development. The exposition varies at these mid-level theories. Mostly the students do not have enough experience for the implementation.

The most difficult part is the ‚professional' level. These complex methodologies are declared as unknown. We have to reveal that the designers are unacquainted with these techniques. University education is not the field for this level of inventive thinking approach. Special courses are available, but the introduction takes very long time, and the reach of functional routine of usage cannot be guaranteed.

3 Problems that Occur by the Application of the Methods

Various explanations have been given for the low level of acceptance of methods in practice. Birkofer (2005) and Jaensch (2007) have pointed to the problematic transfer and application of methods into practice. According to their work one of the most critical conditions is the way that methods are presented and formulated. The critical factors are the following: firstly the inadequate advertisement of methods, secondly the inappropriate representation of the techniques, thirdly instead of application the knowledge is addressed, and finally there is no differentiation along design disciplines.

These issues are related to the performance of methods and addresses the question of whether it is proven that design methods really lead to superior design performance. Even when methods are applied, the design performance can still be low because of the poor use of techniques or the quality of the theory itself. Low per-

formance can be caused by a mismatch between characteristics of the chosen method and the project, due to the incorrect timing of the process (Badke-Schaub et al. 2011).

3.1 Lack of Use of the Theories

Few of the methods presented in the previous chapter are used in the field of industrial companies. Possible causes of this include:

- Lack of knowledge or only a superficial acquaintance.
- The use of the methods is time consuming. Time always plays a key role at the industrial processes. All industrial projects are limited to specified deadline-ranges.
- The motivation level of the designers is low, in many cases they are not motivated to use the methods at all. In general, we get the same result – whether the designers use any methods or not, because they usually aim to reach a satisfying solution.
- The following problems are arising in psychological level. The designers – as individuals – have different attitudes. This issue is related to the lack of motivation.
- Inadequate communication. Generally the designers work in a team. The inappropriate communication – inside the group or extended to corporate level – frequently becomes a reason of failure.
- For a successful solution search a high experience level is essential according to empirical investigations. (Badke-Schaub & Frankenberger 1999)

3.2 Suggestions for Eliminating the Deficits

Our goal is to eliminate these factors. Our suggestions for improvement are the following:

- The theoretical training has to be followed a strict practical course where the use of the specifically chosen methods are not only suggested but applied in practice. During the education the designer students are obliged to have a real experience of usage, so later in the industrial environment the designers will have practical application-level knowledge.

— Time factor is always a great pressure on the designer. A possible solution to resolve this issue is a deliberate development schedule, where the usages of systematic methods are built into the different stages.
— Several factors must be considered to achieve the adequate level of motivation – psychological aspects, corporate site and management issues. By the use of proper implementation strategies the motivational level could be increased.
— The design team must be prepared to admit the design methods. At individual level the designers should not be satisfied with the achievement of an adequate solution (Leicht et al. 2007).
— The goal would be the exploitation of the new forms of communication. For example a methodological knowledge database would be available for filtering the uncertainty factors of the theoretical background or reviving the former knowledge that can be used effectively.
— With more training and practise the level of experience could be increased.

From the list of deficits above – the developers do not have application-level knowledge is considered as the main problem. The roots can be found at the field education. In the next chapter we examine students' projects, in order to identify the causes.

4 Case study

Those educational concepts, which impart methodological approaches and allow students to practice them on a design cases in a team setting, can enable novices to deal with complex design tasks (Grimheden and Hanson 2005). But besides the implementation of these educational approaches an evaluation of teaching concepts has to be undertaken, in order to assure a high quality of design education (Achten et al. 2005).

The observed training course is offered to graduate students of industrial design engineering in order to allow them to get acquainted

with different, commonly known design methods, to apply these methods to a concrete design case, and to experience team work in the design process.

We have intended to find out whether methods taught in the training course of the first semester were applied appropriately by the participants – that means according to the goals of the methods.

At the Budapest University of Technology and Economics our Department of Machine and Product Design offers Integrated Product Design courses which are based on each other starting with the clarification of the methodological grounds.

At the fourth semester of the Bachelor level education the students get a well-defined task to design a faucet. After several ideas and two development phases the participants create 2 product suggestions, so in each semester in average 150 proposals are made. In the recent years' pattern, from these plans only 15-20 new concepts can be called as blockbuster ideas.

As their documentations of the design process were examined, we found that the students has come to their versions less by using the methods, more by following a genuine idea or by their personal intuition. The generally known techniques and evaluation methods appeared by the idea generation phase.

The question is what is the reason of not using the learned methods? What is the point in no application? Mostly at the educational environment the usage of the previously acquainted methods is not an exact criteria to fulfil the requirements of the semester. The supervisor tutor does not force the students to the application of the techniques. The environment does not motivate the participants, the theoretical knowledge cannot reach the level of practical application. Such trainings would be necessary that some of the selected methods are shown in specific application examples.

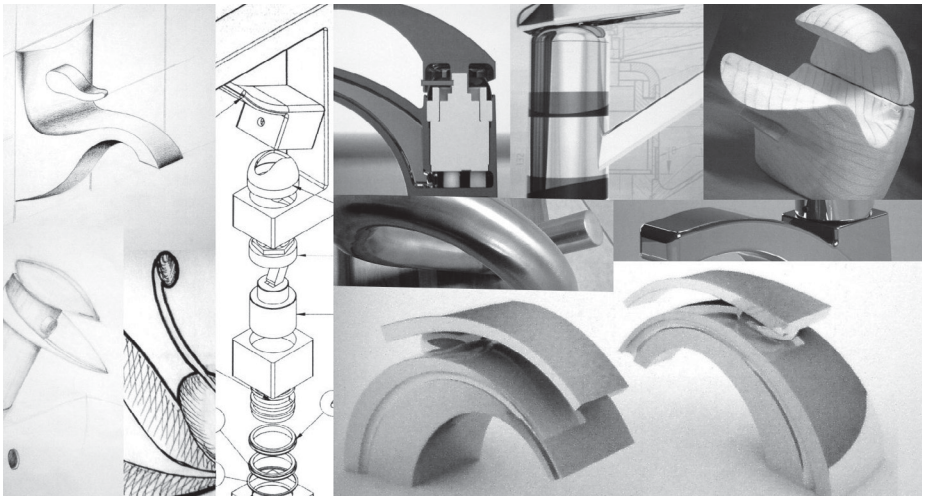

Figure 2: Students works from 2012.

5 Suggestions from the Perspective of Education

A reorganisation of the education from a methodological aspect is required. The systematic application criteria of the methodology must be implemented. During the design projects the individual steps must be specifically defined that the student are forced to always use more and more complicated methods.

Another objective is to create the adequate motivation. A possible opportunity is to organize competitions. For example an 'innovation award', as the reward for the best design process can also make the students motivated. The implementation of this strategy can be started at institutional level followed by national or international competitions.

It is essential to start with the advanced level training of the supervisors and tutors, which aims to actualize their theoretical knowledge, and of course to make them capable to effectively transfer their knowledge to the students to achieve the application-level practise at the universities.

6 Conclusion

In order to meet the increasing demands of product innovation standards, the methodological support of the designers, and the preparation of the students of engineering design to cope with these requirements gain more importance than ever. The designers have to be prepared to choose the appropriate method at the specific situation where it is required. The basic principles of design methodology offer essential support for the designers but we always have to consider that this knowledge is built upon and needs to be integrated with human characteristics. With a feasible categorization on the system of methodologies is more conceivable. With the improvement of the implementation of the theories at the educational level the reach of a higher innovation rate at the early stage of the design process is more predictable.

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